

Introducing solid foods and vitamin and mineral supplementation during infancy

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INTRODUCTION – The primary objective of feeding during the first year is the acquisition of nutrients for optimal growth [1]. The balance of energy intake to energy needs is of primary importance [2]. Secondary goals include the acquisition of motor skills and appropriate eating behaviors.

Feeding development is a "learned progression of behaviors" [1]. It is dependent upon structural integrity and neurologic maturation and compounded by individual temperament, interpersonal relationships, environmental influences, and culture. Feeding practices during the first two years of life help to establish lifelong eating patterns, so it is important to develop healthy eating habits [2-4].

The introduction of complementary foods (sometimes called "weaning foods") and the need for vitamin and mineral supplementation during the first year of life will be discussed here. Breastfeeding and dietary recommendations for toddlers and preschool children and issues related to the introduction of solid foods in infants at high risk for allergy are discussed separately

- (See "[Infant benefits of breastfeeding](#)".)
- (See "[Breastfeeding: Parental education and support](#)".)
- (See "[Dietary recommendations for toddlers, preschool, and school-age children](#)".)
- (See "[Introducing formula to infants at risk for allergic disease](#)".)
- (See "[Introducing highly allergenic foods to infants and children](#)".)

INFANT NUTRITIONAL REQUIREMENTS – Energy requirements for infants vary depending upon age; approximate requirements are as follows ([figure 1](#)) [5]:

- 0 to 2 months – 100 to 110 kcal/kg per day
- 3 to 5 months – 85 to 95 kcal/kg per day
- 6 to 8 months – 80 to 85 kcal/kg per day
- 9 to 11 months – 80 kcal/kg per day

Actual energy requirements for an infant vary depending on individual characteristics including medical needs and catch-up growth [5].

Energy intake is influenced by the number of eating occasions, number of foods consumed, energy density of foods consumed, and portion size [6]. Infants have an innate ability to self-regulate energy intake (eg, they consume larger portions when they are fed less frequently; they consume smaller portions of energy-dense foods) [6]. However, innate self-regulation may be overcome by factors that diminish hunger-driven eating behavior (eg, coercive feeding, restriction of intake, environmental cues) [6,7].

Requirements for selected nutrients for infants are presented in the table ([table 1](#)).

HUMAN MILK AND INFANT FORMULA – Human milk is the ideal food for full-term infants [9]. Adequate intake of human milk or commercial infant formula meets the nutritional requirements for infants in the first six months of life. Thereafter, complementary foods help to supplement energy, iron, vitamins, and trace elements, and prepare the infant for a more diversified diet [8]. (See "[Nutritional composition of human milk for full-term infants](#)".)

Other types of milk (eg, unmodified cow's milk, goat's milk, and plant-based milks other than soy commercial infant formulas) are unsuitable for infants younger than 12 months. They have inappropriate proportions of protein, fat, and carbohydrates or insufficient quantities of vitamins or minerals (eg, vitamin D, folate).

COMPLEMENTARY FOODS – Complementary foods (sometimes called "weaning foods") are solid foods and liquids other than human milk or infant formula that are eaten by infants as they make the transition from a liquid diet to a modified adult diet. By the end of the first year of life, most healthy infants obtain approximately one-half of their energy needs from complementary foods [2].

WHEN TO INITIATE COMPLEMENTARY FOODS

Optimal timing – Based upon physiologic needs and neurodevelopmental maturation, complementary foods are optimally introduced between four and six months of age [9]. Although age is generally a good predictor of readiness to eat solid foods, the use of age as the sole predictor may overlook the needs of the individual infant, particularly the infant who was born prematurely. (See "[Developmental skills](#)" below.)

By four months of age, most infants have doubled their birth weight. By six months of age, complementary foods become necessary to support growth, satisfy hunger, and supplement energy and nutrient needs [10]. After six months of age, the volume of human milk ingested by exclusively breastfed infants becomes insufficient to meet the infant's requirements for energy, protein, iron, zinc, and some fat-soluble vitamins [11]. (See "[Infant nutritional requirements](#)" above.)

Delay of introduction of complementary foods until at least four months of age may provide some benefit in reducing the risk of atopic dermatitis and atopic sensitization in infants at risk for allergic disease [12]. (See "[Introducing highly allergenic foods to infants and children](#)", section on "[Introduction in a high-risk population](#)".)

For breastfed infants, waiting until the infant is at least six months old to introduce complementary foods may prevent gastrointestinal infections without compromising growth. In a systematic review of controlled trials and observational studies (from both developed and developing countries) infants who were exclusively breastfed for six months had growth that was comparable to that in infants who received complementary foods beginning at four months, but had fewer gastrointestinal infections [13]. (See "[Infant benefits of breastfeeding](#)".)

Developmental skills – The introduction of solid foods should be delayed until the infant is able to sit with support and has good head and neck control [14]. This developmental milestone can be easily and correctly determined by most mothers. Babies who can sit with support usually have achieved the other skills necessary to successfully eat solid foods:

- Adequate truncal control (indicated by the ability to push up from the prone position with straight elbows) [9].
- The ability to propel pureed foods to the posterior pharynx for swallowing.
- Extinction of the extrusion reflex (usually between four and five months of age). The extrusion reflex involves raising the tongue and pushing it against any object that is placed between the child's lips [15]. Persistence of the extrusion reflex makes spoon feeding difficult and frustrating for both the mother and the infant.
- Preparation for the varying textures of supplemental foods by putting their hands in their mouths, bringing their toys to their mouths, and exploring different ways of mouthing these objects [10].

- The ability to indicate a desire for food (by opening the mouth and leaning forward) and satiety (by leaning back or turning away). This is usually achieved by five to six months of age.

Additional skills are necessary to eat lumpy foods and finger foods. (See [How to advance](#) below.)

Early introduction – Early introduction refers to introduction of complementary foods before four months of age.

Lack of benefit – Introduction of complementary foods before four months of age has no known benefit. Parents often report that early introduction of cereal helps infants to sleep through the night, but evidence for this benefit is lacking. This issue was evaluated in a trial in which 106 infants were randomly assigned to receive a bedtime bottle containing rice cereal (1 tablespoon per ounce) at five weeks or four months [16]. The addition of cereal was not associated with increased duration of sleep.

The early introduction of allergenic foods to infants who are not at risk of allergy is discussed separately (See ["Introducing highly allergenic foods to infants and children", section on 'Introduction in the general population'](#))

Potential harms – Introduction of complementary foods before four months of age is possibly harmful:

- The introduction of solid foods before an infant has the oral motor skills to safely swallow them may result in aspiration [17].
- Initiation of complementary foods before four to six months of age may result in inadequate or excess intake of energy or nutrients and increased renal solute load [18].
- Early initiation of solid foods has been associated with an increased risk of obesity in some studies [19-24], but not in all [25-28]. (See ["Definition, epidemiology, and etiology of obesity in children and adolescents", section on 'Metabolic programming'](#).)
- Feeding cereals to infants at high risk for type 1 diabetes mellitus before three months of age may increase the risk of development of islet cell antibodies. (See ["Pathogenesis of type 1 diabetes mellitus", section on 'Cereals'](#).)
- The relationship between infant feeding practices and celiac disease is discussed separately. (See ["Epidemiology, pathogenesis, and clinical manifestations of celiac disease in children", section on 'Infant feeding practices'](#).)

Potential harms of delayed introduction – Withholding the introduction of complementary foods until after the infant is six months of age also may be associated with adverse effects, including [29-34]:

- Decreased growth because of inadequate energy intake (see ["Failure to thrive \(undernutrition\) in children younger than two years: Etiology and evaluation", section on 'Etiology'](#))
- Iron deficiency in the breastfed infant if iron supplementation is not provided as recommended (see ["Iron deficiency in infants and children <12 years: Screening, prevention, clinical manifestations, and diagnosis", section on 'Recommendations for iron supplementation'](#))
- Delayed oral motor function
- Aversion to solid food
- Development of atopic disease (asthma, allergic rhinitis, eczema, food allergies); the introduction of solid foods to infants at high risk of developing allergic disease is discussed separately (see ["Introducing highly allergenic foods to infants and children", section on 'Introduction in a high-risk population'](#))
- Type 1 diabetes mellitus; delaying the introduction of cereals to infants at high risk for type 1 diabetes mellitus until after seven months of age may increase the risk of development of islet cell antibodies (see ["Pathogenesis of type 1 diabetes mellitus"](#))

WHAT TO FEED AND HOW TO ADVANCE – The types of supplemental food presented to young children are influenced by culture, tradition, and individual preference [1,11,35]. Feeding practices and preferences established during infancy appear to persist in early childhood [36-38].

The infant's growth should be monitored at each health care visit to detect and address slow growth or other nutritional problems. (See "[Clinical evaluation of the obese child and adolescent](#)" and "[Normal growth patterns in infants and prepubertal children](#)", section on 'Evaluation of growth' and "[Failure to thrive \(undernutrition\) in children younger than two years: Etiology and evaluation](#)", section on 'Terminology'.)

The guidelines below are based upon the recommendations of the American Academy of Pediatrics (AAP) and the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committees on Nutrition [11,14,39].

What to feed – Complementary foods should be used in conjunction with human milk or commercial infant formula to provide the full range of nutrients needed for infant growth, development, and health (table 1) [14]. As solid foods are introduced, consumption of formula or human milk should gradually be reduced to 28 to 32 ounces per day (table 2) [15]. (See '[Infant nutritional requirements](#)' above.)

- Single-ingredient foods should be introduced first [14]. The AAP Committee on Nutrition suggests that infant cereals and puréed meats be offered first because they provide iron and zinc, which are the nutrients most likely deficient in the diets of infants in the United States [4,40,41]. Puréed meats provide heme iron, which is more bioavailable than nonheme iron, and increase the absorption of nonheme iron [42]. Once these foods are accepted, strained or puréed fruits and vegetables may be added. (See '[Cereals](#)' below and '[Puréed foods](#)' below.)
- At least one feeding per day should contain foods rich in vitamin C to promote iron absorption.
- Fat and cholesterol intake are not restricted in infants. The ESPGHAN Committee on Nutrition recommends that fat constitute at least 25 percent of energy intake in infants [11].
- The addition of sugar and salt is discouraged [43]. Adding sugar and salt does not increase the infant's acceptance of foods. Avoiding added sugar and salt during infancy may help to set a lower threshold for sweet and salty tastes later in life [11,44,45].
- Overconsumption of energy-dense complementary foods may induce excessive weight gain in infancy which may have long-term implications [46-48]. (See "[Definition, epidemiology, and etiology of obesity in children and adolescents](#)", section on 'Metabolic programming'.)

Cereals – Single-grain infant cereals are good choices for the first supplemental food because they supply additional energy and iron [49]. Rice cereal traditionally is offered first because it is the least allergenic and is easily accessible. Caregivers who are concerned about potential contamination of rice cereal with arsenic can be counseled to offer a variety of cereals [50], including those made from oats [51-54]. Evidence that delaying the introduction of wheat products until after six months of age prevents development of wheat allergy is lacking. (See "[Arsenic exposure and poisoning](#)", section on 'Dietary ingestion' and "[Introducing highly allergenic foods to infants and children](#)", section on 'Introduction in the general population'.)

Infant cereals can be prepared by adding human milk, infant formula, or water. Cereal should be offered initially in small amounts (1 teaspoon) at the end of breast- or bottle-feeding. The amount of cereal should be gradually increased to a target of approximately one-half cup per day by 6 to 8 months of age (table 2).

Cereal should be fed with a spoon. Spoon feeding enhances oral motor function, which may influence speech development.

Cereal should not be added to bottles, except if medically indicated for gastroesophageal reflux (GER). Adding cereal to bottles delays the opportunity to learn to eat from a spoon. In addition, adding cereal to the bottle may contribute to the development of obesity by increasing the caloric density of formula or by confusing the body's

signals for satiety and thirst. Infants with GER whose management includes adding cereal to the bottle should also receive cereal from a spoon when they are developmentally ready for solid foods. (See "[Gastroesophageal reflux in infants](#)" and "[Gastroesophageal reflux in premature infants](#)".)

Puréed foods – A variety of puréed foods should gradually be added to provide diverse and balanced "meals." Single-ingredient purées are recommended initially. The AAP Committee on Nutrition suggests that infant cereals and puréed meats as excellent first foods that are well accepted by infants and provide necessary iron supplementation [4,40]. Advancing the complexity and texture of puréed foods is discussed below (See '[Purées](#)' below.)

By 8 to 12 months of age, caregivers should be encouraged to offer fruits and vegetables at least once per day, to offer a variety of fruits and vegetables, and to offer fruits and vegetables that are initially refused at subsequent meals [7,38,55-57]. Variety is the key; evidence that vegetables should be offered more or less frequently than fruits is lacking. The acceptability of new foods increases with repeated exposure; up to 15 exposures may be necessary before a new food is accepted [9,58-61]. Breastfeeding may facilitate the acceptance of solid foods as a result of the variety of flavors transmitted through human milk [8,59].

In a longitudinal follow-up of the Infant Feeding Practices Study II, consumption of fruits and vegetables less than once per day during infancy was associated with infrequent intake of fruits and vegetables at six years of age [37]. In another longitudinal study, six-year-old children who had been offered a variety of vegetables at the onset of complementary feedings were more willing to try new vegetables, ate more new vegetables, and liked new vegetables more than children who were offered little or no variety of vegetables at the onset of complementary feedings [38]. Offering a vegetable that was disliked initially at eight subsequent meals was associated with increased acceptance of that vegetable and continuing to like and eat that vegetable at three and six years of age.

- **Home-prepared puréed foods** – Parents may choose to prepare puréed foods at home for a variety of reasons (eg, freshness, increased variety and texture, cost, avoidance of preservatives, etc). The [US Food and Drug Administration](#) provides guidelines for safe preparation of baby food at home.

If puréed foods are prepared at home, it is important to ensure that the energy and nutrient content is adequate ([table 1](#)). In observational studies, many home-prepared foods were low in certain nutrients (energy, fat, protein, iron, and zinc) and the nutrient content of home-prepared foods was more variable than that of foods prepared commercially [62-64]. (See '[Infant nutritional requirements](#)' above.)

Home-prepared spinach, beets, green beans, squash, and carrots should not be given to infants younger than four months of age. These foods may contain sufficient nitrate to cause methemoglobinemia [5,66]. (See "[Genetics and pathogenesis of methemoglobinemia](#)".)

Parents should read food labels for sodium content and buy 'no added salt' products. Canned foods should not be used for the home preparation of puréed infant foods if they contain large amounts of added salt and sugar. The dietary reference intake for sodium is 120mg/day for infants 0 to 6 months of age and 370 mg/day for infants 7 to 12 months of age [67].

- **Storage of puréed foods** – Care must be taken to avoid spoilage of puréed foods. Jars of infant foods, once opened, may be refrigerated for a maximum of 48 hours before being discarded. Commercial foods should be served from a bowl rather than out of the jar; food left in the bowl should be discarded.

Foods to avoid and foods not to avoid – Certain foods should be avoided in infants younger than one year of age. They include hard, round foods (eg, nuts, grapes, raw carrots, and round candies), which can lead to choking [14,15], and honey (because of the association of honey with infant botulism) [68]. (See "[Botulism](#)".)

In addition, the AAP suggests that unmodified cow's milk be avoided in infants younger than 12 months of age. (See '[Beverages to avoid](#)' below.)

Highly allergenic foods (eg, eggs, fish, peanuts/peanut butter, tree nuts) may be introduced to infants at age four to six months, even if the infant is at risk for allergic disease, provided that the choking hazard is addressed (eg, by using a thin layer of peanut butter or pureeing peanuts/peanut butter with fruits or vegetables). Delaying the introduction of foods considered to be highly allergenic beyond the age of four to six months was previously suggested as a way to prevent atopic disease in high-risk children (those with a first-degree relative with documented allergic disease). However, various professional groups, including the AAP Committee on Nutrition and Section on Allergy and Immunology and the ESPGHAN Committee on Nutrition, found no convincing evidence that this practice has a significant protective effect. The introduction of highly allergenic foods to infants is discussed separately (See ["Introducing formula to infants at risk for allergic disease"](#) and ["Introducing highly allergenic foods to infants and children"](#).)

Beverages to avoid – Certain beverages should be avoided during the first year of life:

- **Cow's milk** – The AAP Committee on Nutrition recommends that the consumption of whole cow's milk be avoided before the infant is one year of age because of the increased renal solute load and the increased risk of iron deficiency [1,69-72]. (See ["Iron deficiency in infants and children <12 years: Screening, prevention, clinical manifestations, and diagnosis"](#), section on 'Dietary factors'.)

The ESPGHAN Committee on Nutrition suggests that cow's milk not be used as the main drink before 12 months of age; small volumes of cow's milk may be added to complementary foods [11].

- **Plant-based milks** – Plant-based milks other than soy milk infant formula (eg, rice, almond, coconut) generally should be avoided because they may not meet the infant's nutritional needs [73]. However, for infants who must avoid cow's milk and soy milk and will not consume hydrolysate formulas, plant-based milks may be the only alternative. For such infants, consultation with a dietician to review the overall dietary nutrient intake may be warranted.
- **Fruit juice** – Fruit juice (including 100-percent fruit juice) generally should not be offered to infants younger than 12 months. For infants between 6 and 12 months, we suggest consumption of mashed or pureed whole fruit rather than 100-percent fruit juice unless the juice is medically necessary. This suggestion is in agreement with the 2017 AAP policy on fruit juice in infants, children, and adolescents [39]. If parents choose to offer juice to infants when it is not medically necessary, consumption of 100-percent fruit juice should be limited to ≤ 4 ounces (120 mL) per day.

Fruit juice provides no nutritional benefit for infants and may have adverse consequences, such as undernutrition, overnutrition, diarrhea, flatulence, abdominal distension, and dental caries [74-79]. Although calcium-fortified juices provide a bioavailable source of calcium, they lack other nutrients present in human milk and infant formula (eg, magnesium, protein). (See ["Failure to thrive \(undernutrition\) in children younger than two years: Etiology and evaluation"](#), section on 'Etiology' and ["Preventive dental care and counseling for infants and young children"](#), section on 'Dietary habits'.)

When medically necessary (eg, for the management of constipation, to promote the absorption of iron in infants with iron deficiency), infants should consume 100-percent fruit juice rather than "fruit drinks," which contain added sweeteners and flavors, and be offered from a cup when age appropriate. The juice should be pasteurized; unpasteurized fruit juice may contain pathogens (eg, *Escherichia coli* O157:H7). (See ["Prevention and treatment of acute constipation in infants and children"](#), section on 'Acute constipation' and ["Iron deficiency in infants and children <12 years: Treatment"](#), section on 'Oral iron therapy' and ["Differential diagnosis of microbial foodborne disease"](#).)

The use of fruit juice in the management of dehydration is discussed separately (See ["Oral rehydration therapy"](#), section on 'Common household beverages and fluids'.)

- **Sugar-sweetened beverages** – Consumption of sugar-sweetened beverages (eg, soda, tea, coffee, fruit-flavored drinks) should be avoided during infancy [80]. In a longitudinal follow-up of the Infant Feeding Practices Study II, consumption of sugar-sweetened beverages during infancy was associated with

increased risk of obesity at six years of age (17 versus 8.6 percent) [81]. Sugar-sweetened beverage consumption is also associated with increased risk of dental caries [82].

How much to feed – Overfeeding may induce excessive weight gain in infancy, which may have long-term implications [46-48]. Infants should be permitted to stop eating when they indicate that they are full (eg, by leaning back or turning away) [14,83-85]. Attempts to get the infant to eat as much as possible at bedtime in hopes that he or she will sleep through the night should be discouraged [43]. There is no evidence that this practice is effective [16]. It may lead to overeating by overriding the infant's innate ability to regulate energy intake. (See "[Definition: epidemiology, and etiology of obesity in children and adolescents](#)", section on '[Metabolic programming](#)'.)

How to advance – The complexity and texture of complementary foods are advanced in parallel with the infant's development of feeding skills [9,11].

Purées – Single-ingredient foods should be introduced one at a time at intervals of three to five days to permit the identification of food intolerance [14]. The AAP Committee on Nutrition suggests infant cereals and puréed meats as excellent first foods; once these foods are accepted, strained or puréed fruits and vegetables can be added [14]. The objectives are to introduce a variety of foods, tastes, and textures by the end of the first year and to ensure that the combination of human milk and complementary feedings meet the infant's nutritional requirements (table 1). (See '[Infant nutritional requirements](#)' above.)

The first solid foods offered should be finely puréed, contain only one ingredient, and should not contain additives (salt, sugar). Combination foods (eg, fruit and cereal, meat and vegetable) may be given after the child tolerates the individual components.

Once thin purées are tolerated and the infant can sit independently and grasp food with his or her hands, thicker purées and soft mashed foods can be introduced [85]. By around eight months of age, infants have usually mastered thick purées and have developed sufficient tongue flexibility to chew and swallow food with more texture (ground food, mashed foods with small, soft lumps) in larger portions (table 2) [11,85]. Lumpier blends often contain puréed food with small pieces of pasta, vegetables, or meat. The incremental increase in varieties of textures is important to the acquisition of normal chewing and swallowing skills and the acceptance of different textures [32].

Finger foods – By 8 to 10 months of age, infants begin to refine the skills necessary to eat finger foods independently. These skills include the ability to sit independently; the eye-hand coordination needed to grasp, manipulate, and release food; the ability to "chew" (even in the absence of teeth); and to swallow. By the time the infant is 12 months of age, the hand grasp matures to a fine pincer grasp, improving the ability to eat finger foods.

Finely chopped, soft foods (eg, small pieces of soft fruits, vegetables, cheese, well-cooked meats, cooked pasta, etc) and foods that dissolve easily (eg, baby crackers, dry cereal) can be offered as finger foods [85]. Foods that are choking hazards should be avoided [14]. These foods include hot dogs, nuts (particularly peanuts), grapes, raisins, raw carrots, popcorn, and round candies [14,15].

Self-feeding – By 9 to 12 months of age, most infants have the manual dexterity to feed themselves, drink from a standard cup using two hands, and eat foods prepared for the rest of the family with minor adaptations (eg, cut into bite-sized portions). Nonetheless, a combination of independent and dependent feeding is necessary to satisfy the energy and nutrient needs of the child during this phase of improving self-feeding skills [9]. (See '[Infant nutritional requirements](#)' above.)

Feeding environment – The development of healthy eating habits requires a healthy feeding environment and a healthy feeding relationship [85-87]. In a healthy feeding relationship, the infant initiates and guides feeding interactions, and the caregiver must:

- Respond early and appropriately to hunger and fullness cues

- Recognize the infant's developmental abilities and feeding skills
- Balance the infant's need for help with encouragement of self-feeding

MINERAL AND VITAMIN SUPPLEMENTATION

Iron – The minimum daily requirements for iron vary depending upon gestational age and birth weight as follows [88]:

- Full-term infant – 1 mg/kg
- Premature infant and low-birth-weight infants – 2 to 4 mg/kg

Breastfed infants – After four months of age, the iron requirement of a full-term breastfed infant may exceed the amount that can be provided by human milk alone. In addition to human milk, some form of iron supplementation (eg, pureed meats, iron-fortified infant cereal, iron-rich vegetables, liquid iron supplement) is recommended to provide a total of at least 1 mg/kg per day [11,88-90]. From 7 to 12 months of age, iron intake should be 11 mg/day. In general, an average of two servings (a total of 30 g or one-half of a cup of dry cereal) of iron-fortified cereal in combination with human milk is sufficient to meet the daily iron requirement. As complementary foods are introduced, those higher in iron content (table 3) should be offered early. Parents should be encouraged to read product labels carefully to verify serving size and percent daily value of iron contained in each product. Until iron needs are met by the intake of complementary foods, supplementation with oral liquid iron is appropriate. (See "[Iron deficiency in infants and children <12 years: Screening, prevention, clinical manifestations, and diagnosis](#)", section on 'Prevention of iron deficiency'.)

Formula-fed infants – Infants who receive iron-fortified formula (12 mg elemental iron per liter) do not need additional iron supplementation.

Low-birth-weight and preterm infants – The iron stores of preterm infants often are depleted by two to three months of age. These infants should receive at least 2 mg/kg per day of iron throughout the first year of life [88,91]. (See "[Iron deficiency in infants and children <12 years: Screening, prevention, clinical manifestations, and diagnosis](#)".)

Fluoride – If necessary, fluoride supplementation begins when the child is six months of age. The dose of fluoride supplementation depends upon the fluoride concentration in the water source (for those using powdered or concentrated infant formula) (table 4) and whether the infant is exposed to other sources of fluoride (eg, fluoride toothpaste) [92,93].

Ready-to-feed infant formulas are produced with water that does not contain fluoride. Fluoride supplementation, beginning at six months of age, is warranted for infants who are fed ready-to-feed formula as the sole source of nutrient and fluid intake. Fluoride supplementation should begin at six months of age for exclusively breastfed infants, as well.

The effects of water filtration systems on the fluoride content of bottled water are discussed separately. (See "[Preventive dental care and counseling for infants and young children](#)", section on 'Fluoride'.)

Once teeth are present, fluoride varnish may be applied to all children every three to six months in the primary care or dental office [94]. (See "[Preventive dental care and counseling for infants and young children](#)", section on 'Topical fluoride application'.)

Vitamin D – Vitamin D supplementation should be provided to exclusively breastfed infants and non-breastfed infants who do not ingest an adequate amount of vitamin D-fortified milk daily. The recommended daily intake and timing, duration, and dose of vitamin D supplementation are discussed separately (See "[Vitamin D insufficiency and deficiency in children and adolescents](#)", section on 'Vitamin D supplementation for infants'.)

Vitamin B12 – The adequate intake (AI, previously RDA) for vitamin B12 (cobalamin) is 0.4 mcg per day for infants between birth and six months of age and 0.5 mcg per day for infants between 7 and 12 months.

[Vitamin B12](#) supplementation is recommended for breastfed infants of strict vegan mothers (ie those who avoid eggs and dairy products in addition to meat) if the mother is not taking supplemental vitamin B12 while lactating and for formula-fed infants whose parents provide a strictly vegan complementary diet [95]. The adverse neurologic consequences of vitamin B12 deficiency may be devastating and irreversible. Physiologically active vitamin B12 is available from supplements and in some fortified cereals, soy beverages, and nutritional yeast. (See "[Maternal nutrition during lactation](#)", section on 'Vitamins and minerals' and "[Vegetarian diets for children](#)", section on 'Vitamin B12' and "[Overview of acquired peripheral neuropathies in children](#)", section on 'Vitamin B12 (cobalamin) deficiency')

Fat-soluble vitamins— Supplementation with fat-soluble vitamins (vitamins A, D, E, and K) should be considered in infants who have chronic cholestatic liver disease or fat malabsorption [96]. (See "[Biliary atresia](#)", section on 'Fat-soluble vitamin supplements'.)

SOCIETY GUIDELINE LINKS— Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately (See "[Society guideline links: Vitamin deficiencies](#)" and "[Society guideline links: Breastfeeding and infant nutrition](#)".)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or email these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword[s] of interest.)

- Basics topics (see "[Patient education: Starting solid foods with babies \(The Basics\)](#)" and "[Patient education: Weaning from breastfeeding \(The Basics\)](#)")
- Beyond the Basics topics (see "[Patient education: Starting solid foods during infancy \(Beyond the Basics\)](#)" and "[Patient education: Weaning from breastfeeding \(Beyond the Basics\)](#)")

SUMMARY AND RECOMMENDATIONS

- Energy requirements for infants range from 80 to 110 kcal/kg per day, depending upon age. Infants have an innate ability to self-regulate energy intake that may be affected by factors that diminish hunger-driven eating behavior. Requirements for selected nutrients for infants are presented in the table ([table 1](#)). (See '[Infant nutritional requirements](#)' above.)
- Adequate intake of human milk or commercial infant formula meets the nutritional requirements for infants in the first six months of life. By the end of the first year of life, most healthy infants obtain approximately one-half of their energy needs from complementary foods. (See '[Human milk and infant formula](#)' above and '[Complementary foods](#)' above.)
- We suggest that complementary foods be introduced between four and six months of age if the infant is able to sit with support and has good head and neck control ([Grade 2C](#)). (See '[When to initiate complementary foods](#)' above.)
- Complementary foods should be used in combination with human milk or commercial infant formula to provide the full range of nutrients needed for infant growth, development, and health ([table 1](#) and [table 2](#)). Complementary foods should be offered using a spoon or infant feeder; they should not be added to a bottle unless medically necessary (eg, for gastroesophageal reflux). (See '[What to feed](#)' above.)

- Single-ingredient foods should be introduced first. We suggest that infant cereals and pureed meats be offered initially ([Grade 2C](#)). Once these foods are accepted, pureed fruits and vegetables may be added. At least one feeding per day should contain foods rich in vitamin C. The addition of sugar and salt to complementary foods is discouraged. Honey and foods that may lead to choking should be avoided. (See ['What to feed'](#) above.)
- Fruit juice (including 100-percent fruit juice) generally should not be offered to infants younger than 12 months. For infants between 6 and 12 months, we suggest consumption of mashed or pureed whole fruit rather than 100-percent fruit juice unless the juice is medically necessary ([Grade 2C](#)). (See ['Beverages to avoid'](#) above.)
- When fruit juice is medically indicated, infants should consume pasteurized 100-percent fruit juice rather than "fruit drinks," which contain added sweeteners and flavors. The juice should be offered from a cup rather than a bottle when age appropriate. (See ['Beverages to avoid'](#) above.)
- Infants should be permitted to stop eating when they indicate that they are full (eg, by leaning back or turning away). (See ['How much to feed'](#) above.)
- The complexity and texture of complementary foods are advanced in parallel with the development of feeding skills. Combination foods can be given after the infant tolerates the individual components. The texture of foods is advanced initially from thin to thick purees. By approximately eight months of age, infants can usually chew and swallow more solid foods (eg, cooled pasta, vegetables). Between 8 and 10 months of age, infants usually can begin to eat finger foods. By 9 to 12 months of age, most infants can feed themselves, but they require a combination of dependent and independent feeding to satisfy energy and nutrient needs. (See ['How to advance'](#) above.)
- Breastfed infants require some form of iron supplementation (iron-fortified infant cereal, pureed meats, iron-rich vegetables, liquid iron supplements) beginning at four months of age to meet their iron requirement (1 mg/kg per day). Infants who receive iron-fortified formula do not require additional iron supplementation. (See ['Iron'](#) above.)
- [Fluoride](#) supplementation begins when the child is six months of age, depending upon the fluoride concentration in the water source ([table 4](#)) and whether the infant is exposed to other sources of fluoride. (See ['Fluoride'](#) above.)
- Vitamin D supplementation should be provided to exclusively breastfed infants and non-breastfed infants who do not ingest an adequate amount of vitamin D-fortified infant formula daily (See ["Vitamin D insufficiency and deficiency in children and adolescents", section on 'Vitamin D supplementation for infants.'](#))

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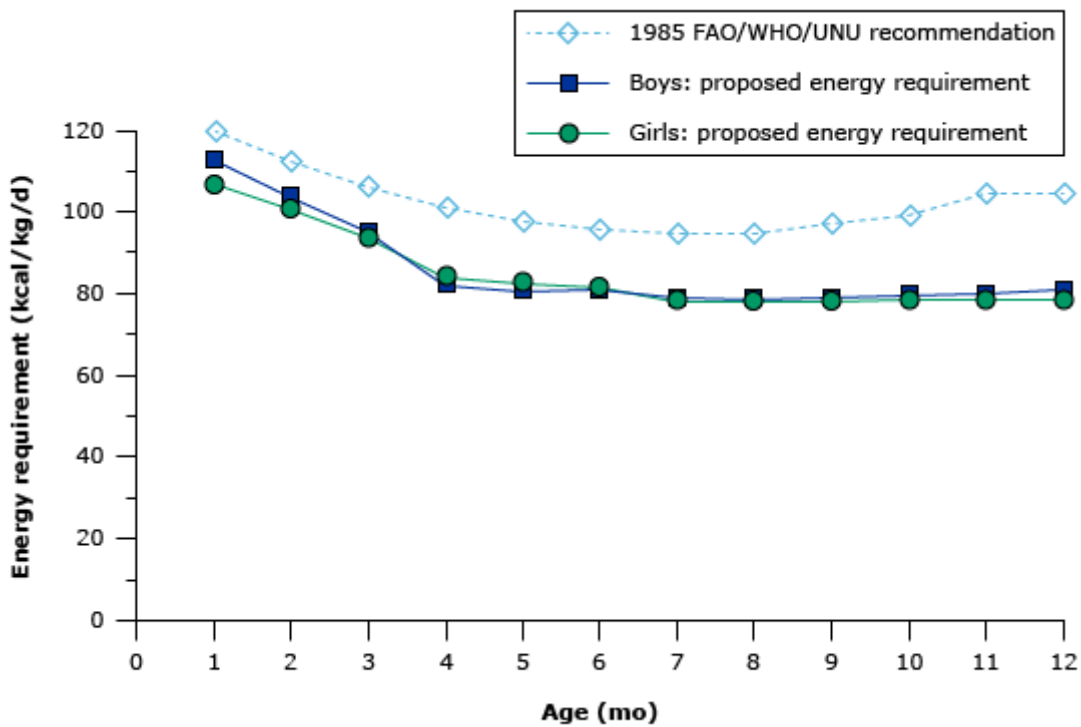
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Topic 2855 Version 53.0

GRAPHICS

Energy requirements of infants, FAO/WHO/UNU



Energy requirements of healthy infants 0 to 12 months of age as estimated by the joint FAO/WHO/UNU Expert Consultation on Energy in Human Nutrition in 2001 (closed symbols), combining data for breastfed and formula-fed infants. The 1985 FAO/WHO/UNU estimates are shown for comparison (open symbol).

FAO: Food and Agriculture Organization of the United Nations; WHO: World Health Organization; UNU: United Nations University.

Food and Agriculture Organization of the United Nations, 2004, Human energy requirements: Report of a Joint FAO/WHO/UNU Expert Consultation. Food and Nutrition Technical Report Series 1, <http://www.fao.org/docrep/007/y5686e/y5686e05.htm>.

Graphic 87702 Version 1.0

Dietary reference intakes of selected nutrients for infants

	0 to 6 months	7 to 12 months
Carbohydrate	60 g/day	95 g/day
Fat	31 g/day	30 g/day
Protein	1.52 g/kg per day	1.2 g/kg per day
Calcium	200 mg/day*	260 mg/day*
Iron	0.27 mg/day [¶]	11 mg/day
Zinc	2 mg/day	3 mg/day

* These values represent the Adequate Intake for calcium; there was insufficient scientific data to calculate a recommended dietary allowance (RDA).

¶ The iron stores of full-term infants whose birth weight was appropriate for gestational age meet their iron requirement until four to six months of age.

Data from:

1. Committee on Nutrition American Academy of Pediatrics. Appendix E-1. Dietary Reference Intakes: Recommended Intakes for Individuals, Food and Nutrition Board, Institute of Medicine. In: *Pediatric Nutrition Handbook*, 7th ed, Kleinman RE (Ed), American Academy of Pediatrics, Elk Grove Village, IL 2014. p.1355.
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Infant feeding guide

Food	Age (months)				
	0 to 4	4 to 6	6 to 8	8 to 10	10 to 12
Breast milk (#feedings)	Frequent feedings (8 to 12)	Frequent feedings (4 to 6)	On demand (3 to 5)	On demand	On demand
Iron-fortified formula (#feedings)	16 to 32 oz (8 to 12)	24 to 40 oz (4 to 6)	24 to 32 oz (3 to 5)	16 to 32 oz (3 to 4)	16 to 24 oz (3 to 4)
Cereals, bread	None	None	Infant cereal 1 to 4 tablespoons twice per day	Infant cereals Cream of wheat Other plain hot cereals Toast, bagel, crackers 2 to 3 servings/day*	Unsweetened hot or cold cereals Bread Rice Noodles 4 servings/day*
Fruit	None	None	Fresh/cooked puréed fruits Mashed bananas Applesauce 1/2 cup per day	Peeled, soft fruit wedges Bananas, peaches, pears, oranges, apples 1 to 2 servings/day*	All fresh fruits, peeled and seeded Canned fruits, packed in water or fruit juice 2 servings/day*
Vegetables	None	None	Strained or mashed vegetables Dark yellow, orange, or green (avoid corn) 1/2 cup per day	Cooked and mashed fresh or frozen vegetables 1 to 2 servings/day*	Cooked vegetable pieces 2 servings/day*
Protein foods	None	None	Puréed meats 1 to 2 servings per day*	Lean meat, chicken, or fish (strained, chopped, or small tender pieces) Egg yolk Cooked dried beans 3 to 4 servings per day*	Small tender pieces of meat, chicken, or fish (1 to 2 oz) Egg yolk Cheese Cooked dried beans 3 to 4 servings per day*
Fruit juice	None	None	None	None	None

* One serving size is considered to be 1 tablespoon.

Adapted from: Massachusetts WIC program Nutrition Education Task Force.

Graphic 70327 Version 9.0

Iron-rich complementary commercial baby foods for infants

Food	Serving size	Elemental iron (mg)
Meat		
Lamb, junior	2.5 ounces (74 g)	1.2
Chicken, strained	2.5 ounces (74 g)	1.0
Lamb, strained	2.5 ounces (74 g)	0.8
Beef, junior or strained	2.5 ounces (74 g)	0.7
Chicken, junior	2.5 ounces (74 g)	0.7
Pork, strained	2.5 ounces (74 g)	0.7
Ham, strained or junior	2.5 ounces (74 g)	0.7
Cereal		
Oatmeal, dry, fortified	1 tablespoon (15 mL)	2.0
Brown rice, dry, instant	1 tablespoon (15 mL)	1.8
Rice, dry, fortified	1 tablespoon (15 mL)	1.3
Barley, dry, fortified	1 tablespoon (15 mL)	1.1
Vegetables		
Green beans, junior	4 ounces (120 g)	1.3
Peas, strained	4 ounces (120 g)	1.1
Green beans, strained	4 ounces (120 g)	0.8
Spinach, creamed or strained	4 ounces (120 g)	0.7

Data from: United States Department of Agriculture. Agricultural Research Service. USDA National Nutrient Database for Standard Reference. Available at <https://ndb.nal.usda.gov/> (Accessed on March 1, 2016).

Graphic 107092 Version 1.0

Recommended dietary fluoride supplement* schedule

Age	Fluoride concentration in community drinking water		
	<0.3 ppm [¶]	0.3 to 0.6 ppm	>0.6 ppm
0 to 6 months	None	None	None
6 months to 3 years	0.25 mg/day	None	None
3 to 6 years	0.5 mg/day	0.25 mg/day	None
6 to 16 years	1 mg/day	0.5 mg/day	None

* Sodium fluoride (2.2 mg sodium fluoride contains 1 mg fluoride ion).

¶ ppm: parts per million; 1 ppm = 1 mg/L.

Reproduced from MMWR Recommendations and Reports 2001; 50:RR-14. Sources: Meskin LH. J Am Dent Assoc 1995; 126 (suppl):1S; American Academy of Pediatric Dentistry. Pediatr Dent 1995; 16 (special issue):1 American Academy of Pediatrics. Pediatrics 1995; 95:777.

Graphic 69038 Version 4.0

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Teresa K Duryea, MD Nothing to disclose **Jan E Drutz, MD** Nothing to disclose **Kathleen J Motil, MD PhD** Nothing to disclose **Mary M Torchia, MD** Nothing to disclose

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